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THE ABSORPTION SPECTRUM OF AMERICIUM

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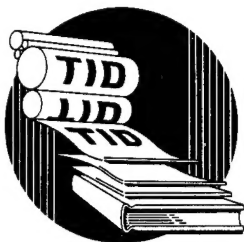
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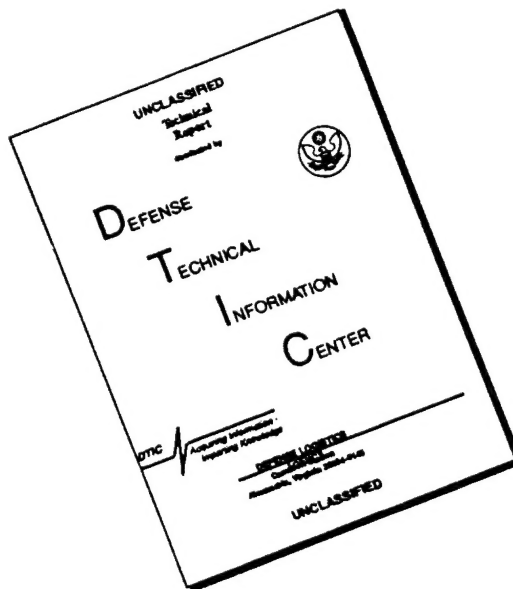
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THE ABSORPTION SPECTRUM OF AMERICIUM*

By B. J. Stover, J. G. Conway, and B. B. Cunningham

ABSTRACT

The absorption spectra of aqueous solutions and solid compounds of americium have been investigated with a Baird 3-meter grating spectrograph.

The relation of the spectrum to that of other actinide and rare-earth compounds is discussed.

INTRODUCTION

It has long been observed that the absorption spectra of the trivalent rare-earth ions possess a unique sharpness, the structure of the peaks being discernible at room temperature and even in solutions. This phenomenon has also been observed in the case of the electronically analogous actinide elements.

The generally accepted explanation for the origin of the lines in the rare-earth spectra is that they result from transitions within the 4f electron shell.

Trivalent europium, the analog of americium, has been shown by absorption spectra and magnetic susceptibility data to have a 4f⁶ electron configuration, a ⁷F₀ ground state, and one or more low-lying excited levels. Since americium ion probably has a 5f⁶ configuration, it also is expected to have a singlet ground state and one or more low-lying excited levels. The following represents the first phases of the study of the absorption spectrum of americium.

EXPERIMENTAL

Apparatus

A Baird Eagle Mount Spectrograph, having 5.6 Å/mm dispersion in the first order, was used for both the solution and crystal work. For the solutions a 1-cm path-length cell 2 mm wide was mounted on the arm of a micromanipulator. The cell was then placed as close to the slit as possible. The cell was of fused silica. For the wavelength below 3500 Å a water-cooled hydrogen discharge lamp was used, and above 3500 Å a tungsten filament lamp was used.

Since the amount of americium available is not sufficient to permit the growing of large crystals, a projection system had to be used. Light from a tungsten lamp was focused on the crystal, and an image of the crystal was focused on the slit of the spectrograph. The crystals were mounted in a cell made of 1/8-in. thick brass which had thin glass windows attached.

Solution Absorption Spectrum

The absorption spectrum of trivalent americium in perchloric acid solution has been measured in the wavelength range 2200 to 10,000 Å, and the results appear in Table 1. The spectrograms show a marked similarity to those of rare-earth solutions, but the americium absorption is much more intense. The absorption in the 5000 Å region is especially strong, and it was found to persist at very low concentrations.

*Work performed under Contract No. W-7405-eng 48.

The measurements were made using a solution 0.04M in americium and 0.5M in perchloric acid. However, to detect the four components of the 5000 Å peak, it was necessary to reduce the americium concentration to about 10 per cent of the above. With this solution none of the other lines were discernible.

Solid Absorption Spectrum

The absorption spectrum of samples of hydrated americium chloride containing approximately 100 µg of americium has been measured in the region 3500 to 5500 Å at room temperature (Table 2). Work is now in progress to extend this range and to obtain similar data at low temperatures.

The samples were prepared by slow evaporation of americium chloride solutions which had been carefully purified and which were approximately neutral.

The peak at 5000 Å was resolved into ten components, compared with the four found with the solution. To measure these ten accurately, it was necessary to photograph samples of several different thicknesses.

This work was performed under the auspices of the U. S. Atomic Energy Commission.

Table 1—Am³⁺ in HClO₄ at Room Temperature

Table 2—Hydrated AmCl₃ at Room Temperature

| λ, Å | $\bar{\nu}$, cm ⁻¹ | λ, Å | $\bar{\nu}$, cm ⁻¹ |
|------|--------------------------------|------|--------------------------------|
| 8133 | 12,292 | 5168 | 19,346 |
| 5166 | 19,353 | 5163 | 19,364 |
| 5104 | 19,588 | 5154 | 19,397 |
| 5078 | 19,686 | 5139 | 19,454 |
| 5030 | 19,875 | 5104 | 19,587 |
| 4543 | 22,003 | 5084 | 19,664 |
| 4287 | 23,318 | 5060 | 19,756 |
| 4198 | 23,815 | 5047 | 19,808 |
| 4018 | 24,882 | 4991 | 20,030 |
| 3784 | 26,420 | 4974 | 20,098 |
| 3771 | 26,510 | 4695 | 21,293 |
| 3756 | 26,617 | 4646 | 21,517 |
| 3605 | 27,732 | 4639 | 21,550 |
| 3391 | 29,477 | 4596 | 21,752 |
| 3353 | 29,817 | 4555 | 21,948 |
| 3312 | 30,189 | 4429 | 22,572 |
| 2893 | 34,553 | 4320 | 23,138 |
| 2861 | 34,940 | 4314 | 23,170 |
| 2847 | 35,118 | 3940 | 25,374 |
| 2826 | 35,380 | 3800 | 26,307 |
| 2754 | 36,299 | 3786 | 26,406 |
| 2705 | 36,952 | 3761 | 26,578 |
| 2699 | 37,037 | 3660 | 27,310 |
| 2651 | 37,715 | 3621 | 27,602 |
| 2597 | 38,490 | | |
| 2537 | 39,406 | | |
| 2436 | 41,038 | | |
| 2433 | 41,096 | | |

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